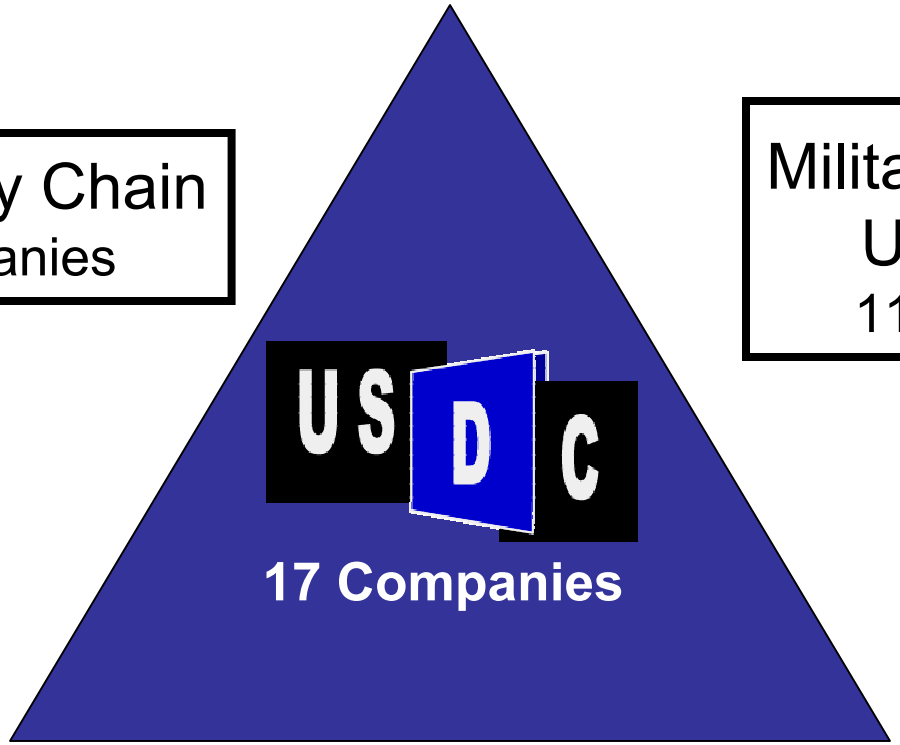
About USDC

- Chartered in 1993
- Industry consortium focused on flat panel display (FPD) manufacturing and infrastructure
- 17 companies form the consortium with support from the U.S. Army Research Laboratory (ARL)

USDC's Interactions

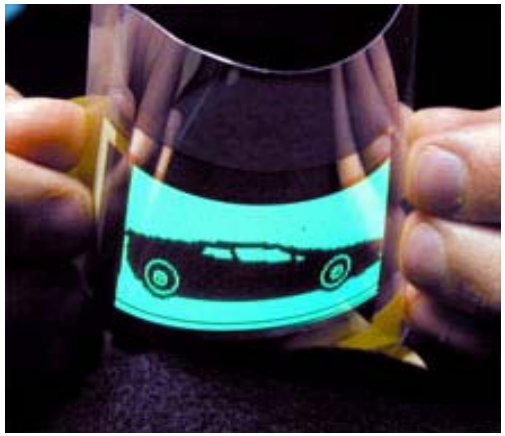
FPD Supply Chain
60 Companies

Military & Avionics
User Group
11 Companies



Media, Government, &
Financial Communities

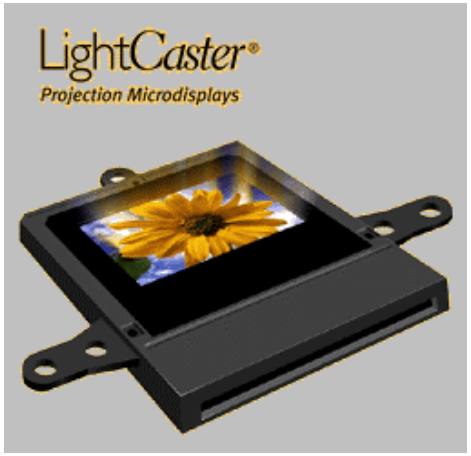
Voting Members



- Cambridge Display Technology
- dpiX, LLC
- DuPont Displays
- IBM Corporation
- Philips Research USA
- Three-Five Systems
- Universal Display Corporation
- U.S. Army Research Lab
- Defense Advanced Research Projects Agency

General Members

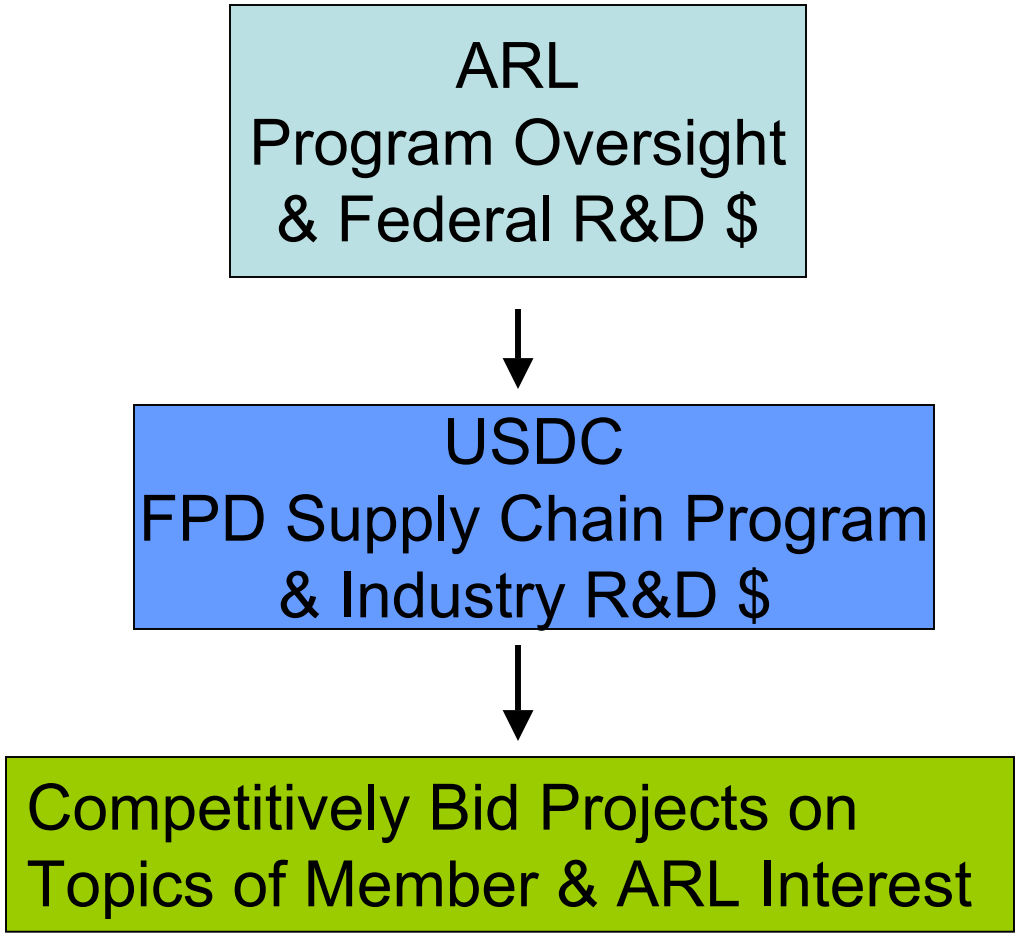
- Displaytech, Inc.
- E-Ink Corporation
- eMagin
- FlexICs Inc.
- Kodak
- iFire Technology
- Iridigm Display Corp.
- Microvision, Inc.
- Versatile Information Products
- White Electronics Designs Corp.



Military & Avionics User Group

- Barco nv BarcoView
- Boeing Company
- General Dynamics Canada
- Honeywell International
- Interface Displays & Controls
- Kaiser Aerospace & Electronics
- L-3 Communications Corp.
- L-3 AMI
- Lawrence Livermore National Labs
- Luxell Technologies
- Rockwell Collins

Army Research Lab & USDC Relationship



USDC Program Scope

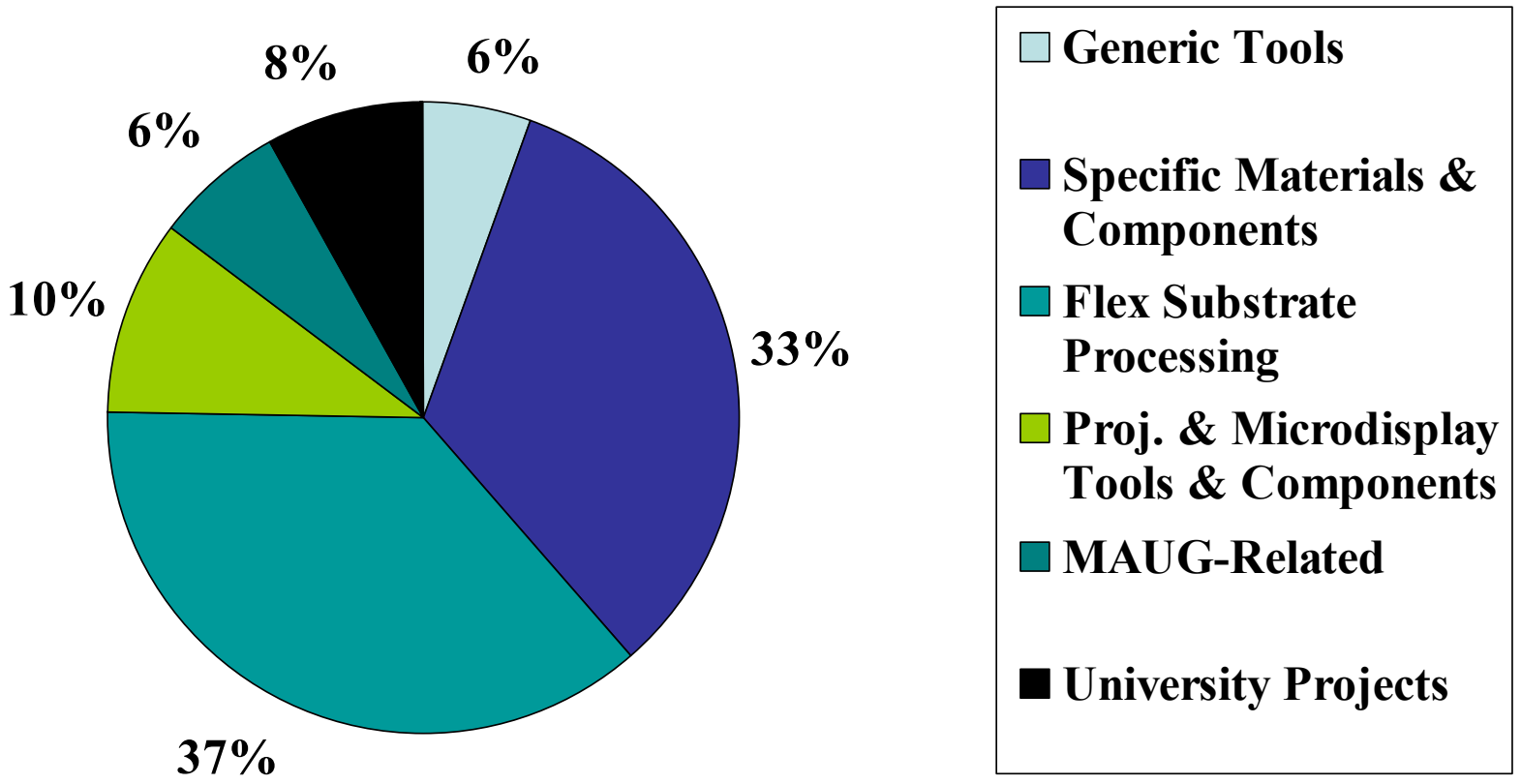
- **USDC projects enhance manufacturing capability for microdisplays, projection systems, organic light emitting diodes (OLEDs) and flexible substrate technology.**

- **All three tiers of industry are represented in USDC**
  - **display users**
  - **display manufacturers and developers**
  - **equipment, materials and components suppliers.**

- **Widely shared results optimize efficiency and flexibility, since several alternatives can be simultaneously explored.**

2003 Technical Program Spending Plan – as of Oct. 2003

35 projects @ $30.2M with > 50% industry matching



Ongoing USDC Activity

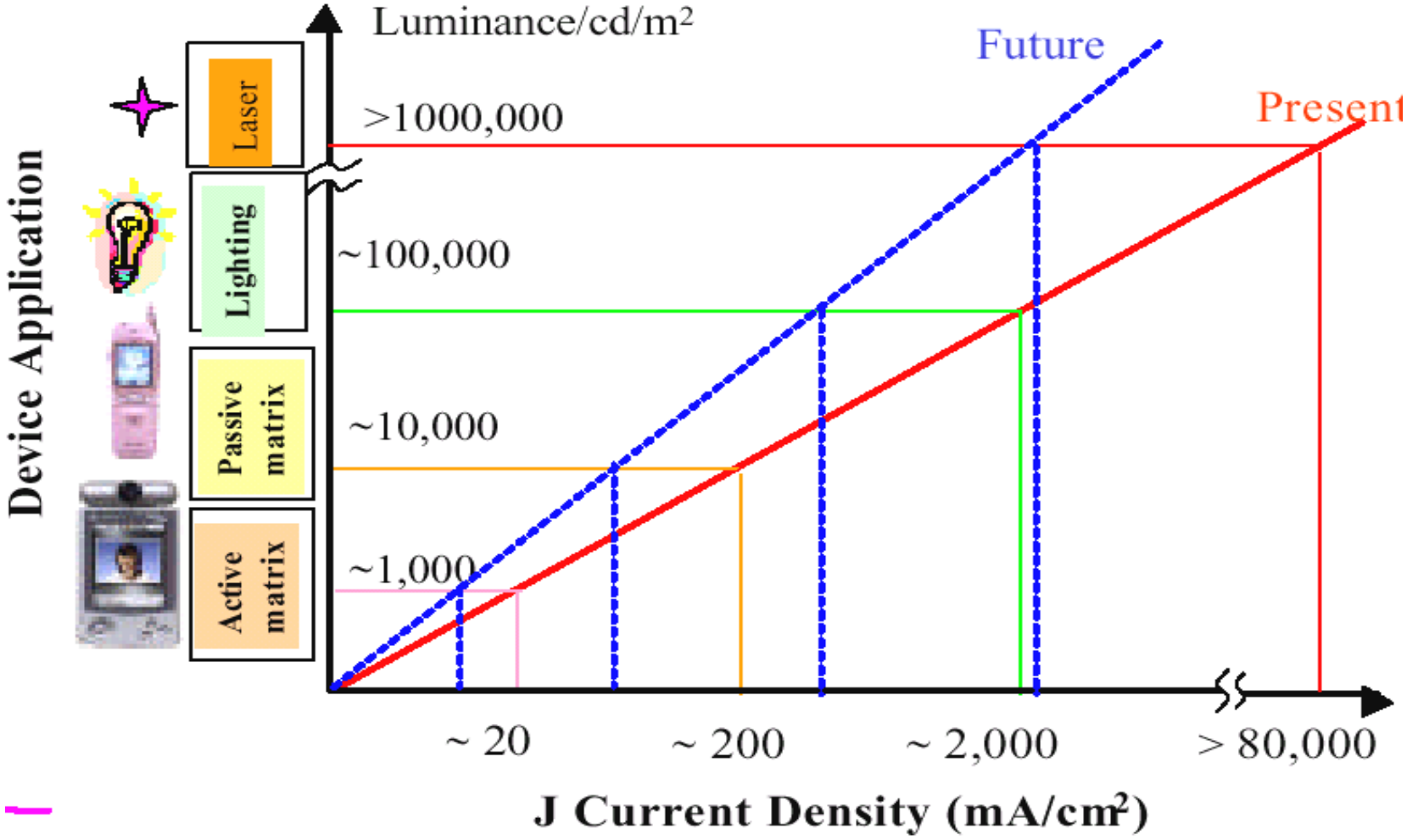
- **Identify and address supply chain gaps by funding R&D projects.**
- **Promote members in technical and financial forums.**
- **Provide valuable information, such as technology roadmaps, technical trends and market information**
- **Foster international cooperation among display consumers, display makers and tools and materials suppliers.**

Major OLED Development Issues

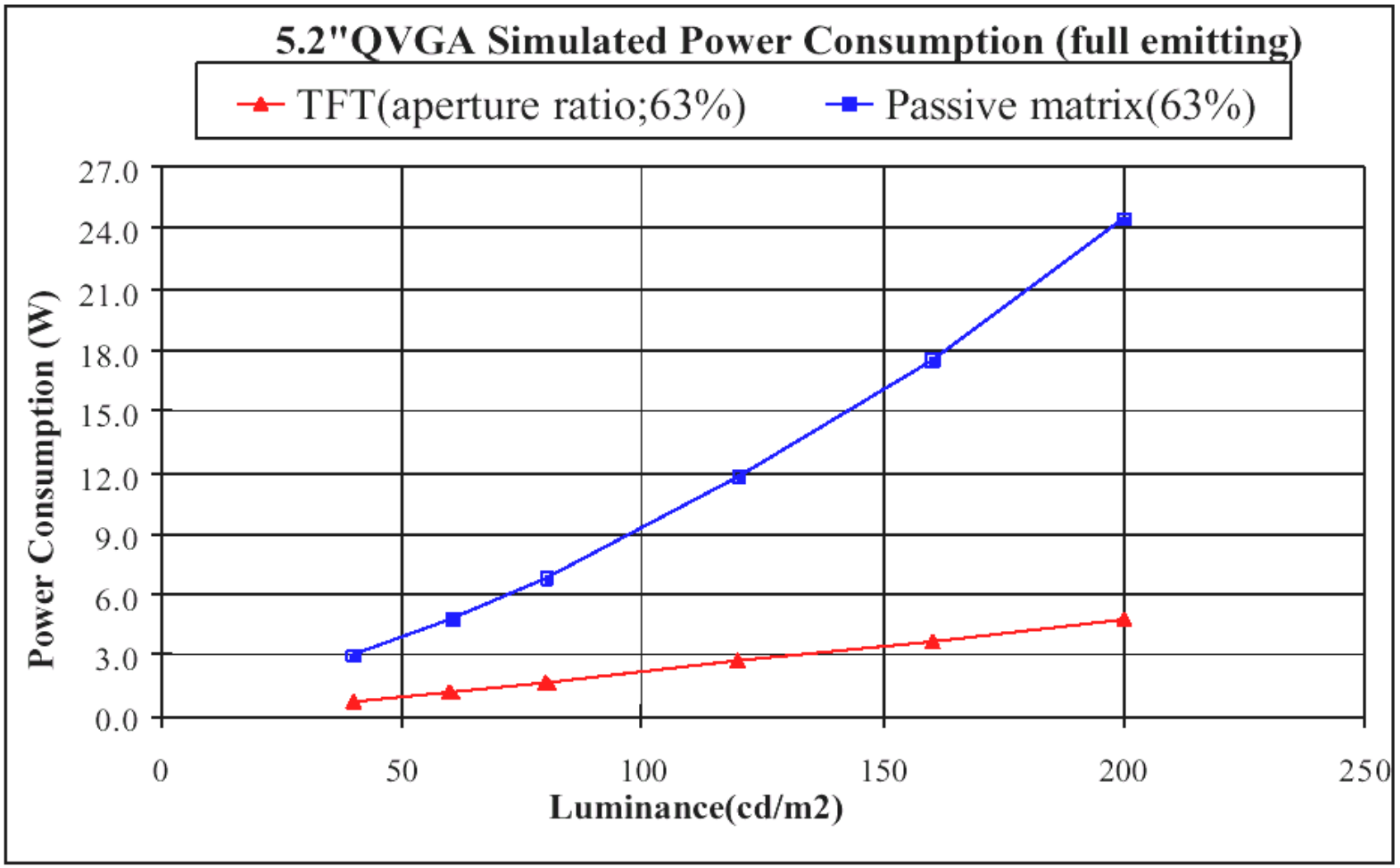
Displays versus General Lighting

- **Parameters unique to displays**
  - Fine patterning
  - Contrast
  - Pixel switching
  - Color saturation (NTSC standard)
- **Parameters unique to general lighting**
  - White light with high CRI
  - Uniformity over very large area
- **Parameters in common**
  - Conversion efficiency (%)
  - Luminous efficiency or efficacy (lm/w)
  - Luminance (lm/m^2)
  - Stability (differential aging)
  - Lifetime
  - Cost
  - Environmental protection (encapsulation)
  - Materials selection & optimization

OLEDS for Displays versus General Lighting



OLED Power Consumption



Target cost/performance parameters for OLEDs in diffuse lighting applications

Property	Units	Stage 1	Stage 2	Stage 3	Stage 4
Date	Year	2004	2007	2010	2013
Diode energy efficiency	%	5	12.5	20	30
Diode efficacy	lm/W	20	50	80	120
Color rendering index	CRI	75	80	85	90
Lifetime from 2000 cd/m^2	hours	10K	20K	40K	50K
Maximum panel width	in	14	40	40	>40
Panel thickness	mm	2.0	1.0	0.5	0.5
Panel weight	gm/cm^2	0.5	0.25	0.1	0.1
Fabrication costs	$/sq m	120	60	40	30

Target cost/performance parameters for OLED displays

Property	Units	Stage 1	Stage 2	Stage 3
Date	Year	2004	2007	2010
System efficiency	%	1	2	4
System efficacy	lm/W	4	6	10
Blue saturation	CIE (x+y)	<0.33	<0.25	<0.2
Green saturation	CIE y	>0.6	>0.7	>0.75
Red saturation	CIE x	>0.65	>0.67	>0.7
Lifetime from 200 cd/m^2	hours	5K	10K	20K
Pixel density	ppi	100	200	200-300
Contrast @ 500 lux	VESA 2.0	50	100	200
Max pixel number		1M	5M	10M
Maximum diagonal size	in	20	40	60
Panel thickness	mm	2.0	1.0	0.5
Maximum voltage swings	V	8	5	3
Panel weight	gm/cm^2	0.5	0.25	0.1
Fabrication costs	$/sq inch	5.00	1.00	0.50

USDC Member Interest Profile

- **OLED development**
  - Cambridge Display Tech. - Philips
  - DuPont Displays - Universal Display Corp.
  - Kodak

- **LED development**
  - Displaytech - Luminus Devices
  - CREE - Perkin Elmer
  - General Electric - Philips
  - Lumileds

- **Manufacturing Equipment, Processes & Materials**
  - 3M - General Atomics
  - Applied Films - General Electric
  - Avecia - Kurt Lesker
  - CHA Industries - National Starch
  - Corning - Schott Corp.
  - Dow Corning - Vitex Systems

OLED Manufacturing Evolution

- Glass substrates (~Gen II LCD tooling), batch processing, glass/metal lid seals > (for market introduction with minimum innovation)

- Plastic substrates (same tooling), batch processing affixed to rigid substrates, plastic cover layer > (use marketing “glitz” & performance features offered by flexible, contourable, light weight, rugged devices)

- Roll-to-Roll {continuous web} processing on plastic film > (cost driven & larger area capability)

Innovations in Transition to Flexible Substrates

- **Materials**
  - Substrates, e.g., PET, PEN, PC, PES, PAR, PNB, PI & metal foils
  - Barrier layers & Encapsulants (environmental)
  - Hard coats (chemical & scratch resistance)
  - Adhesives & Sealants
  - Getters
  - Transparent conductors

- **USDC Development Projects**
  - Substrates > Dow Chemical, Promerus, GE @ $5.56M
  - Barriers > Battelle, Dow Corning, GE, Symmorphix, Vitex @ $11.25M
  - Permeation measurement > Desert Cryogenics, General Atomics @ $1.02M
  - Adhesives & Sealants > National Starch @ $2.21M
  - Transparent conductors > Northwestern Univ., Cabot @ $2.13M
  - Planarization layers > Dow Corning @ $2.62M

Manufacturing Innovations in Transition to Flexible Substrates

- **Manufacturing Tools (**batch**)**
  - Deposition > Lesker, Litrex @ $6.89M
  - Cleaning > FSI International, Genesis Engineering @ $2.63M
  - Digital lithography > Agilent @ $ 2.81M
  - Flexible substrate lamination/delamination > pending

- **Transition to Roll-to-Roll (**initial target of 24” web**)**
  - Lithography > Azores @ $4.09M
  - Deposition > Lesker, CHA Industries @ $7.75M
  - Factory modeling > AGI @ $0.2M
  - Inspection > pending
  - Cleaning > pending
  - Etching > pending

Related R&D Programs

Flexible Substrates & Emissive Technologies

- **ARL**
  - University-based flexible display R&D center
  - Initial funding @ $43.7M for FY 2004-2008
  - Follow-on funding @ $50M for FY 2009-2013
  - Meet Army transitional requirements for FCS and OFW

- **DARPA**
  - Flexible high-efficiency photovoltaic panels @ source selection
  - Immersive imaging systems @ concept white papers > pre-BAA
  - Large area macroelectronics @ source selection